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WHAT IS CLAIMED IS:

1. A method for plasma plating comprising:
positioning a substrate within a vacuum chamber;
positioning a depositant in a filament within the
vacuum chamber;
reducing the pressure in the vacuum chamber to a
level at or below 4 milliTorr;
introducing a gas into the vacuum chamber at a rate
to raise the pressure in the vacuum chamber to a level at
or between 0.1 milliTorr and 4 milliTorr;
applying a dc signal to the substrate at a voltage
amplitude at or between 1 volt and 5000 volts;
applying a radio frequency signal to the substrate
at a power level at or between 1 watt and 50 watts; and
heating the depositant to a temperature at or above
the melting point of the depositant to generate a plasma
in the vacuum chamber.

2. The method of Claim 1, wherein reducing the
pressure in the vacuum chamber to a level at or below
4 milliTorr includes reducing the pressure in the vacuum
chamber to a level at or below 1.5 milliTorr, and wherein
introducing the gas into the vacuum chamber at a rate to
raise the pressure in the vacuum chamber to a level at or
between 0.1 milliTorr and 4 milliTorr includes
introducing the gas into the vacuum chamber at a rate to
raise the pressure to a level at or between 0.5 milliTorr
and 1.5 milliTorr.

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3. The method of Claim 1, wherein applying the dc
signal to the substrate at a voltage amplitude at or
between 1 volt and 5000 volts includes applying a dc
signal to the substrate at a voltage level at or between
negative 500 volts and negative 750 volts.

4. The method of Claim 1, wherein applying the
radio frequency signal to the substrate at a power level
at or between 1 watt and 50 watts includes applying the
radio frequency signal to the substrate at a power level
at or between 5 watts and 15 watts.

5. The method of Claim 1, wherein applying the
radio frequency signal to the substrate at a power level
at or between 1 watt and 50 watts includes applying the
radio frequency signal to the substrate at a power level
around 10 watts.

6. The method of Claim 1, wherein applying the dc
signal to the substrate includes applying the dc voltage
at a negative polarity, and the plasma includes positive
depositant ions.

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5 7. The method of Claim 1, wherein reducing the
pressure in the vacuum chamber to a level at or below
4 milliTorrr includes reducing the pressure in the vacuum
chamber to a level at or below 1.5 milliTorrr, and
10 introducing the gas into the vacuum chamber at a rate to
raise the pressure in the vacuum chamber to a level at or
between 0.1 milliTorrr and 4 milliTorrr includes
introducing the gas into the vacuum chamber at a rate to
raise the pressure to a level at or between 0.5 milliTorrr
and 1.5 milliTorrr, wherein applying a dc signal to the
15 substrate at a voltage amplitude at or between 1 volt and
5000 volts includes applying a dc signal to the substrate
at a voltage level at or between negative 500 volts and
negative 750 volts, and wherein applying the radio
frequency signal to the substrate at a power level at or
between 1 watt and 50 watts includes applying the radio
frequency signal to the substrate at a power level at or
between 5 and 15 watts.

20 8. The method of Claim 1, wherein positioning the
substrate within the vacuum chamber includes positioning
the substrate on a platform.

25 9. The method of Claim 8, wherein the platform is a
turntable operable to rotate the substrate.

30 10. The method of Claim 9, further comprising:
rotating the turntable at a revolutions per minute
rate at or between 5 revolutions per minute and 30
revolutions per minute.

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5 *SP3*
11. The method of Claim 9, further comprising:
rotating the turntable at a rate of revolutions per
minute at or between 12 revolutions per minute and 15
revolutions per minute.

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12. The method of Claim 9, wherein the turntable
includes an electrically conductive material that
provides an electrically conductive path to the
substrate, and applying the dc signal to the substrate
and applying the radio frequency signal to the substrate
include applying the dc signal and the radio frequency
signal to the electrically conductive material of the
turntable.

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13. The method of Claim 12, wherein applying the dc
signal to the substrate and applying the radio frequency
signal to the substrate include applying the dc signal
and the radio frequency signal to the electrically
conductive material of the turntable using a commutator.

20 *SP4*
14. The method of Claim 12, wherein applying the dc
signal to the substrate and applying the radio frequency
signal to the substrate include applying the dc signal
and the radio frequency signal to the electrically
conductive material of the turntable using an
electrically conductive brush.

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15. The method of Claim 8, wherein the platform is
included as part of the vacuum chamber.

16. The method of Claim 8, wherein the platform is
a flat surface.

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17. The method of Claim 8, wherein the platform includes a horizontal surface.

5 18. The method of Claim 8, wherein the platform includes a vertical surface.

19. The method of Claim 8, wherein the platform includes an inclined surface.

10 20. The method of Claim 8, wherein the platform includes a curved surface.

15 21. The method of Claim 8, wherein the platform includes a curvilinear surface.

22. The method of Claim 8, wherein the platform includes a helical surface.

20 23. The method of Claim 8, wherein the platform is a support structure.

24. The method of Claim 8, wherein the platform includes an electrically conductive material.

25 25. The method of Claim 8, wherein the platform is a conductive plate.

30 26. The method of Claim 8, wherein the platform includes a roller.

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5 *Sub 15* 27. The method of Claim 1, further comprising:
mixing the dc signal and the radio frequency signal
to generate a mixed signal, and wherein applying the dc
signal to the substrate and applying the radio frequency
signal to the substrate includes applying the mixed
signal to the substrate.

10 28. The method of Claim 27, wherein the mixing the
dc signal and the radio frequency signal includes mixing
a negative dc signal and the radio frequency signal.

15 29. The method of Claim 27, further comprising:
balancing the mixed signal by minimizing the
standing wave reflected power.

30 30. The method of Claim 29, wherein minimizing the
standing wave reflected power is achieved using a manual
control.

20 31. The method of Claim 29, wherein minimizing the
standing wave reflected power is achieved using an
automatic control.

25 *Sub 12* 32. The method of Claim 1, further comprising:
positioning the filament at a desired location
relative to the substrate.

30 33. The method of Claim 32, wherein positioning the
filament includes positioning the filament a distance
from the substrate.

34. The method of Claim 33, wherein the distance is
at or between 0.1 inches and 6 inches when the depositant

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in the filament is to be deposited as a base layer.

5 35. The method of Claim 34, wherein the distance is at or between 2.75 inches and 3.25 inches when the depositant in the filament is to be deposited as the base layer.

10 36. The method of Claim 33, wherein the distance is at or between 0.1 inches and 6 inches when the depositant in the filament is to be deposited as a transition layer.

15 37. The method of Claim 36, wherein the distance is at or between 2.75 inches and 3.25 inches when the depositant in the filament is to be deposited as the transition layer.

20 38. The method of Claim 33, wherein the distance is at or between 0.1 inches and 6 inches when the depositant in the filament is to be deposited as a working layer.

25 39. The method of Claim 38, wherein the distance is at or between 2.0 inches and 2.5 inches when the depositant in the filament is to be deposited as the working layer.

40. The method of Claim 1, further comprising:
positioning the filament at a desired location relative to the substrate;

30 positioning a second depositant of the same type as the depositant in a second filament within the vacuum chamber; and

positioning the second filament at a desired location relative to the substrate.

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[illegible]

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41. The method of 40, further comprising positioning the filament a distance from the second filament.

5 42. The method of Claim 41, wherein the distance is at or between 0.1 inches and 6 inches when the depositant in the filament is to be deposited as a base layer.

10 43. The method of Claim 42, wherein the distance is at or between 3.0 inches and 4.0 inches when the depositant in the filament is to be deposited as the base layer.

15 44. The method of Claim 41, wherein the distance is at or between 0.1 inches and 6 inches when the depositant in the filament is to be deposited as a transition layer.

20 45. The method of Claim 44, wherein the distance is at or between 3.0 inches and 4.0 inches when the depositant in the filament is to be deposited as the transition layer.

25 46. The method of Claim 41, wherein the distance is at or between 0.1 inches and 6 inches when the depositant in the filament is to be deposited as a working layer.

30 47. The method of Claim 46, wherein the distance is at or between 2.5 inches and 3.0 inches when the depositant in the filament is to be deposited as the working layer.

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5 Sub
cancel

48. The method of Claim 1, further comprising:
an array of substrates and the substrate is provided
as one of the array of substrates;
positioning the filament at a desired position
relative to outwardly facing surfaces of the array of
substrates;
positioning a second depositant in a second filament
within the vacuum chamber; and
positioning the second filament at a desired
position relative to inwardly facing surfaces of the
array of substrates.

15 Sub

49. The method of 48, wherein the weight of the
second depositant is 20 to 80 percent less than the
weight of the depositant.

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50. The method of 49, wherein the weight of the
second depositant is 40 to 50 percent less than the
weight of the depositant.

25 Sub

51. The method of Claim 1, further comprising:
positioning the substrate at a desired location
relative to the filament.

30

52. The method of Claim 1, further comprising:
positioning a second depositant in a second filament
within the vacuum chamber before reducing the pressure in
the vacuum chamber to a level at or below 4 milliTor; and

heating the second depositant to a temperature at or
above the melting point of the second depositant to
generate a second plasma in the vacuum chamber after the
prior plasma has been generated.

[illegible]

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53. The method of Claim 52, wherein the depositant forms a base layer on the substrate and the second depositant forms a working layer on the base layer.

5 54. The method of Claim 51, further comprising:
positioning a third depositant in a third filament within the vacuum chamber before reducing the pressure in the vacuum chamber to a level at or below 4 milliTorrr; and

10 heating the third depositant to a temperature at or above the melting point of the third depositant to generate a third plasma in the vacuum chamber after the second plasma has been generated.

15 55. The method of Claim 54, wherein the depositant forms a base layer on the substrate, the second depositant forms a transition layer on the base layer, and the third depositant forms a working layer on the transition layer.

20 56. The method of Claim 1, wherein the radio frequency signal is provided at a frequency in the kilohertz range.

25 57. The method of Claim 1, wherein the radio frequency signal is provided at a frequency in the megahertz range.

30 58. The method of Claim 1, wherein the radio frequency signal is provided at a frequency of 13.56 kilohertz.

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59. The method of Claim 1, wherein the radio frequency signal is provided at a frequency reserved for industrial applications.

5 60. The method of Claim 1, further comprising:
cleaning the substrate to remove foreign materials
and oils.

10 61. The method of Claim 1, further comprising:
cleaning the substrate to achieve white metal clean.

15 62. The method of Claim 1, further comprising:
cleaning the substrate before positioning the
substrate within the vacuum chamber.

63. The method of Claim 62, wherein the cleaning
the substrate includes cleaning the substrate to meet a
defined standard.

20 64. The method of Claim 63, wherein the standard is
defined by Steel Structures Painting Council (SSPC).

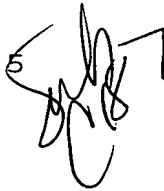
25 65. The method of Claim 63, wherein the standard is
SSPC-5.

66. The method of Claim 63, wherein the standard is
SSPC-10.

30 67. The method of Claim 62, wherein the cleaning
the substrate includes abrasively blasting the substrate.

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68. The method of Claim 1, wherein the gas is introduced through a control valve.

5  69. The method of Claim 1, wherein the depositant is a metal.

70. The method of Claim 1, wherein the depositant is a metal alloy.

10 71. The method of Claim 1, wherein the depositant is gold.

15 72. The method of Claim 1, wherein the depositant is titanium.

73. The method of Claim 1, wherein the depositant is chromium.

20 74. The method of Claim 1, wherein the depositant is nickel.

75. The method of Claim 1, wherein the depositant is silver.

25 76. The method of Claim 1, wherein the depositant is tin.

30 77. The method of Claim 1, wherein the depositant is indium.

78. The method of Claim 1, wherein the depositant is lead.

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79. The method of Claim 1, wherein the depositant is copper.

5 80. The method of Claim 1, wherein the depositant is palladium.

81. The method of Claim 1, wherein the depositant is a silver/palladium metal alloy.

10 82. The method of Claim 1, wherein the depositant is carbon.

15 83. The method of Claim 1, wherein the depositant is a nonmetal

84. The method of Claim 1, wherein the depositant is a ceramic.

20 85. The method of Claim 1, wherein the depositant is a metal carbide.

86. The method of Claim 1, wherein the depositant is a metal nitride.

25 87. The method of Claim 1, wherein the depositant is provided in a form from the class consisting of a pellet, a wire, a granule, a powder, a ribbon, and a strip.

30 88. The method of Claim 1, wherein the gas is an inert gas.

89. The method of Claim 1, wherein the gas is a

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noble gas.

90. The method of Claim 1, wherein the gas is argon.

91. The method of Claim 1, wherein the gas is xenon.

92. The method of Claim 1, wherein the gas is radon.

93. The method of Claim 1, wherein the gas is helium.

94. The method of Claim 1, wherein the gas is neon.

95. The method of Claim 1, wherein the gas is krypton.

96. The method of Claim 1, wherein the gas is oxygen.

97. The method of Claim 1, wherein the gas is nitrogen.

98. The method of Claim 1, wherein the gas is noncombustible.

99. The method of Claim 1, wherein the plasma includes gas ions and depositant ions.

100. The method of Claim 99, wherein the gas ions and the depositant ions of the plasma include positively

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charged ions.

101. The method of Claim 99, wherein the gas ions
and the depositant ions of the plasma include negatively
charged ions.

102. The method of Claim 1, wherein the gas is
argon and the depositant is a metal allow of
silver/palladium, and the plasma includes argon ions and
silver/palladium ions.

103. The method of Claim 1, wherein the filament is
a tungsten basket.

104. The method of Claim 1, wherein the filament is
a boat.

105. The method of Claim 1, wherein the filament is
a coil.

106. The method of Claim 1, wherein the filament is
a crucible.

107. The method of Claim 1, wherein the filament is
a ray gun.

108. The method of Claim 1, wherein the filament is
an electron beam gun.

109. The method of Claim 1, wherein the filament is
a heat gun.

110. The method of Claim 1, wherein the filament is

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~~a support structure.~~

Sub!
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contd

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5 Sub 7
111. The method of Claim 1, wherein heating the depositant includes supplying a current through the filament.

112. The method of Claim 111, wherein heating the depositant includes incremental staging of the current to the filament to achieve a more even heat distribution in the depositant.

10 113. The method of Claim 111, wherein the current is an alternating current.

15 Sub 7
114. The method of Claim 113, wherein the amplitude of the alternating current is controllably increased such that the depositant is more uniformly heated and melted.

20 115. The method of Claim 1, wherein heating the depositant includes heating the depositant through heat generated by a chemical reaction between the depositant and an agent.

25 116. The method of Claim 1, wherein heating the depositant includes heating the depositant through the use of microwave energy.

30 117. The method of Claim 1, wherein the method does not include the addition of a magnet to produce a magnetic field near the substrate that affects the attraction of the ions of the plasma to the substrate.

Sub 7
118. The method of Claim 1, wherein the plasma forms a layer on the substrate with a thickness at or between 500 and 20,000 Angstroms.

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119. The method of Claim 1, wherein the plasma forms a layer on the substrate with a thickness at or between 3,000 and 10,000 Angstroms.

120. The method of Claim 1, wherein the plasma forms a layer on the substrate that can be controlled to a thickness of 500 Angstroms.

121. The method of Claim 1, further comprising:
backsputtering the substrate before heating the depositant to a temperature at or above the melting point of the depositant to generate a plasma in the vacuum chamber.

122. The method of Claim 1, further comprising:
performing backsputtering before heating the depositant that includes:
reducing the pressure in the vacuum chamber to a level at or below 100 milliTorr;

introducing a gas into the vacuum chamber at a rate to raise the pressure in the vacuum chamber at or between 20 milliTorr and 100 milliTorr;

applying a dc signal to the substrate at a voltage amplitude at or between 1 volt and 4000 volts;
and

applying a radio frequency signal to the substrate at a power level at or between 1 watt and 50 watts.

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Sub P13
10 123. The method of Claim 122, wherein reducing the pressure in the vacuum chamber to a level at or below 100 milliTorr includes reducing the pressure in the vacuum chamber to a level at or below 50 milliTorr, and wherein introducing the gas into the vacuum chamber at a rate to raise the pressure in the vacuum chamber at or between 20 milliTorr and 100 milliTorr includes introducing the gas into the vacuum chamber at a rate to raise the pressure at or between 20 milliTorr and 50 milliTorr.

15 124. The method of Claim 122, wherein applying the dc signal to the substrate at a voltage amplitude at or between 1 volt and 4000 volts includes applying a dc signal to the substrate at a voltage amplitude at or between 100 volts and 250 volts.

20 Sub P14 125. The method of Claim 122, wherein applying the radio frequency signal to the substrate at a power level at or between 1 watt and 50 watts includes applying the radio frequency signal to the substrate at a power level at or between 5 and 15 watts.

25 126. The method of Claim 122, wherein applying the dc signal to the substrate includes applying the dc voltage at a negative polarity.

30 127. The method of Claim 122, wherein backspattering is performed for a period of time at or between 30 seconds and one minute.

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128. The method of Claim 122, wherein
backsputtering is performed until the rate of visible
microarcing is significantly reduced.

128. The method of Claim 122, wherein
backsputtering is performed until the rate of visible
microarcing is significantly reduced.

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5 Sub AS
10 129. A method for plasma plating comprising:
positioning a substrate within a vacuum chamber;
positioning a depositant in a filament within the
vacuum chamber;
reducing the pressure in the vacuum chamber to a
level at or between 0.1 milliTorrr and 4 milliTorrr;
applying a dc signal to the substrate at a voltage
amplitude at or between 1 volt and 5000 volts;
applying a radio frequency signal to the substrate
at a power level at or between 1 watt and 50 watts; and
heating the depositant to a temperature at or above
the melting point of the depositant to generate a plasma
in the vacuum chamber.

15 130. The method of Claim 129, wherein applying the
dc signal to the substrate at a voltage amplitude at or
between 1 volt and 5000 volts includes applying a dc
signal to the substrate at a voltage amplitude at or
between 500 volts and 750 volts.

20 131. The method of Claim 129, wherein applying the
dc signal to the substrate includes applying the dc
voltage at a negative polarity, and the plasma includes
positive depositant ions.

25 132. The method of Claim 129, wherein applying the
radio frequency signal to the substrate at a power level
at or between 1 watt and 50 watts includes applying the
radio frequency signal to the substrate at a power level
30 at or between 5 and 15 watts.

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133. The method of Claim 129, wherein applying a dc
signal to the substrate at a voltage amplitude at or
between 1 volt and 5000 volts includes applying a dc
signal to the substrate at a voltage amplitude at or
between 500 volts and 750 volts with a negative polarity,
and wherein applying the radio frequency signal to the
substrate at a power level at or between 1 watt and 50
watts includes applying the radio frequency signal to the
substrate at a power level at or between 5 and 15 watts.

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134. A system for plasma plating comprising:
a vacuum chamber at a pressure defined by a range
that extends from 0.1 milliTorr to 4 milliTorr;
a filament positioned within the vacuum chamber and
operable to receive a depositant;
a depositant positioned at the filament;
a platform positioned within the vacuum chamber;
a substrate positioned at the platform;
a dc power supply generating a dc signal at a
voltage amplitude defined by a range that extends from
1 volt to 5000 volts;
a radio frequency transmitter generating a radio
frequency signal at a power level defined by a range that
extends from 1 watt to 50 watts;
an electrically conductive path that electrically
couples the dc signal and the radio frequency signal to
the substrate; and
a filament power control electrically coupled to the
filament and generating a current through the filament at
an amplitude to generate heat in the filament to melt the
depositant.

135. The system of Claim 134, further comprising a
gas in the vacuum chamber.

136. The system of Claim 135, wherein the gas is a
noble gas.

137. The system of Claim 135, wherein the gas is an
inert gas.

138. The system of Claim 135, wherein the gas is
argon.

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5 139. The system of Claim 134, further comprising:
a vacuum system operable to assist with maintaining
the pressure in the vacuum chamber at the pressure
defined by the range that extends from 0.1 milliTorr to
4 milliTorr; and

10 a gas flowing into the vacuum chamber operable to
assist with maintaining the pressure in the vacuum
chamber at the pressure defined by the range that extends
from 0.1 milliTorr to 4 milliTorr.

15 140. The system of Claim 134, wherein the filament
and the depositant are positioned at a distance no
greater than 6 inches from the substrate.

20 141. The system of Claim 134, wherein the vacuum
chamber is at a pressure defined by a range that extends
from 0.5 milliTorr and 1.5 milliTorr.

25 142. The system of Claim 134, wherein the dc power
supply is generating a dc signal at a voltage amplitude
defined by a range that extends from 500 volts to
750 volts.

30 143. The system of Claim 134, wherein the dc signal
is provided at a negative polarity.

144. The system of Claim 134, wherein the radio
frequency transmitter is generating a radio frequency
signal at a power level defined by a range that extends
from 5 watt to 15 watts.

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5 145. The system of Claim 134, wherein the vacuum chamber is at a pressure defined by a range that extends from 0.5 milliTorr and 1.5 milliTorr, the dc power supply is generating a dc signal at a voltage amplitude defined by a range that extends from negative 500 volts to negative 750 volts, and the radio frequency transmitter is generating a radio frequency signal at a power level defined by a range that extends from 5 watt to 15 watts.

10 146. The system of Claim 134, further comprising:
a dc signal/radio frequency signal mixer mixing the dc signal and the radio frequency signal before the electrically conductive path electrically couples the dc signal and the radio frequency signal to the substrate.

15 147. The system of Claim 146, further comprising:
a radio frequency balancing network receiving the dc signal and the radio frequency signal generated by the dc signal/radio frequency signal mixer and minimizing the standing wave reflected power.

20 148. The system of Claim 147, wherein the minimizing the standing wave reflected power is performed using an automatic control.

25 149. The system of Claim 147, wherein the minimizing the standing wave reflected power is performed using a manual control.

30 150. The system of Claim 134, wherein a magnet is not introduced to produce a magnetic field near the substrate.